PATENT SPECIFICATION

1,139,212

DRAWINGS ATTACHED.

Inventor:—HENRY HOBHOUSE.

1,139,212

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COMPLETE SPECIFICATION.

Improvements in Screw-Type Extruding Machines.

I, HENRY HOBHOUSE, of Bottom Barn, Castle Cary, Somerset, of British Nationality, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to improvements in screw type extruding machines, particularly to means adapted more closely to control the conditions under which an extrudable material is worked.

Such extruding machines are widely used for extruding rubber, plastics, pharmaceutical preparations, foodstuffs, and many other thermoplastic products.

According to the invention there is provided a screw type extruding machine, in which an extrusion screw is driven by an hydraulic motor, the hydraulic feed to which is sensed and the rate of feed to the screw of material to be extruded varied in dependence upon the pressure existing in the hydraulic feed to maintain the force of extrusion at a predetermined optimum.

Thus means may be provided responsive to conditions obtaining in the material either during treatment within the screw barrel or after extrusion such as, for example extrusion pressure, temperature, viscosity, shear-strength, tensile-strength or other criteria known to affect the quality of the extruded product, to effect a variation or limitation on the force applied to the extrusion screw.

The invention is diagrammatically illustrated by way of example in the drawings accompanying the Provisional Specification in which:—

Figure 1 illustrates a screw type extruding machine, and

Figure 2 illustrates a screw type extruding machine adapted for continuous extrusion and means effective to control the characteristics of the products of the extrusion.

As shown in Figure 1 a hydraulic pump 2, of the variable displacement kind, is supplied with fluid from a reservoir 1. The pump 2 supplies fluid to an hydraulic motor 3 which is drivably connected to an extrusion screw 4. A flow control valve 5 is interposed between pump 2 and motor 3 to control the maximum speed of the motor 3. Exhaust fluid from the motor 3 passes through a conduit 6 to a control valve 7 and thence by way of a conduit 8 to a feed motor 9 driving a feed screw 10 to provide a feed of extrudable material to the screw 4. The exhaust from motor 9 returns by way of a conduit 11 and a control valve 12 to the reservoir 1. A control valve 13 is in communication by means of a conduit 14 with the working fluid delivered to the motor 3 through conduit 15 and is adapted to control the exhaust fluid from the feed motor 9 by means of the control valve 12 as hereinafter described and is also adapted to control the flow of treated material through a by-pass or relief passage 16 connecting a part of the extruder barrel adjacent the extrusion orifice with a recirculation port in a feed hopper 17 supplying the feed screw 10. A control valve 18 is provided to permit excess fluid from the control valve 7 to return to the reservoir 1 at certain conditions of pressure and flow.

In operation, the valve 5 is adjusted to permit a rate of flow which will afford the required maximum speed of rotation of the screw 4. Under starting conditions, that is to say when the extruder barrel is empty, the exhaust fluid from the motor 3 is allowed to flow freely through conduits 6, 8 and 11, the valves 7 and 12 and motor 9 to the fluid reservoir 1. The control valve 13 is

inoperative and the by-pass 16 remains closed until the pressure in conduit 15 increases, as resistance to the screw 4 increases on filling of the barrel of the extruder to a predetermined value. At this predetermined value the valve 13 operates to open the by-pass 16 and control the valve 12 to limit the rate of flow of exhaust fluid from the feed motor 9.

When the control valve 13 operates the speed of rotation of the motor 9 is controlled relatively to the pressure in conduit 15, in a manner such that as the pressure in the conduit 15 increases, the speed of the motor 9 and thus the rate of feed of the screw 10 decreases. In the event of the pressure in the conduit 15 decreasing the rate of feed of the screw 10 is increased. The valve 13 is adapted so that the rate of feed of material for extrusion into the extruder barrel by the screw 10 will always be at the rate most suitable for the conditions required for the material being treated.

A thermocouple is included at 19 and is adapted to control through a signal amplifier 20 and an actuator 21 the displacement of the pump 2. For example the thermocouple may serve to reduce the output of the pump 2 and thus the rate of revolution of the motor 3 and the extrusion screw 4 when the temperature of the treated material approaches a value known to be detrimental to the quality of the extruded product. We have found that where the use of P.V.C. is concerned it is desirable not to exceed a barrel temperature of 160°C.

The valve 13 may have a progressive action and may be so arranged that it opens the by-pass 16 to relieve the pressure existing within the extruder barrel while only partially restricting the flow of exhaust fluid from the motor 9 or vice versa in accordance with the properties of material being treated.

During extrusion the valve 18 may be adjusted to ensure that the delivery of extrudable material by the motor 9 and feed screw 10 is related to the output from the extruder screw 4 and may, also, be adjusted to maintain a positive pressure of delivered material at the throat of the feed hopper 17.

The control means illustrated afford an accurate control upon the extrusion and ensure that if extrusion is interrupted, or if the rate of extrusion must be varied, the screw 4 may be suitably controlled throughout a predetermined speed and/or torque range. An extruder provided with the operating and control means of the invention can be readily modified if it is required to be used as an injection machine for the filling of a series of successively presented moulds. Means are provided whereby when mould filling is required, the valve 13 interrupts the by-pass 16 and establishes unrestricted communication between line 11 and the reservoir 1 while the output from the pump 2 is adjusted to a maximum and the valve 5 is by-passed to permit the rotation of the screw at the speed required for effective mould filling. The valve 13 is adjusted to determine the maximum pressure required for injection or, alternatively, a valve 22 may be employed to interrupt the line 14. A fluid pressure accumulator may be included to boost the speed of the screw 4 during mould filling.

In extrusion of materials wherein the physical properties obtained by the material such as, for example, the shear strength or tensile strength are indicative of the quality of the extruded product it is advantageous to employ means responsive to such physical properties of the produced article to control the operation of the extruder manufacturing the article. Thus as shown in Figure 2 the by-pass 16 and the thermocouple 19 are omitted and a take off mechanism 23 is employed in association with means responsive to the physical properties selected as quality criteria. For example in the extrusion of animal feeding stuffs, such as cattle-cake, the shear strength of the extruder material may be an accepted criteria of quality and a chopping or cutting device 24 is employed in which the resistance offered by the extruded material to chopping or cutting is measured and employed to control the force applied by the screw 4 to the material contained in the extruder barrel.

The chopper or cutting device 24 includes a rotary chopper operated by fluid pressure derived from the pump 2 (connections not shown) and includes fluid pressure responsive means adapted to effect a biasing action upon the valve 5 through a conduit 25 in order to vary the speed of the motor 3 and extrusion screw 4 in response to a variation from a norm of the cutting resistance offered by the extruded product.

In an alternative arrangement the device 24 includes sensing means (not illustrated) adapted to effect a control upon the pump 2 by means, for example, of an amplifier and actuator of the kind shown as 20, 21 respectively in the embodiment shown in Figure 1.

Similar arrangements may be provided for the testing of other materials, for example, of P.V.C. or rubber extrusions, except that sensing of the tensile strength may be employed.

WHAT I CLAIM IS:—

1. A screw type extruding machine, in which an extrusion screw is driven by an hydraulic motor, the hydraulic feed to which is sensed and the rate of feed to the screw of material to be extruded varied in dependence upon the pressure existing in the hydraulic feed to maintain the force of extrusion at a predetermined optimum.

2. A machine according to claim 1, in

which a by-pass is provided for material from adjacent an extrusion orifice to a hopper supplying a feed screw, opening and closing of the by-pass being effected in accordance with the pressure existing in the hydraulic feed to the extrusion motor.

3. A machine according to claim 2, in which the pressure existing in the hydraulic feed to the extrusion motor is effective to operate a valve, which valve controls the exhaust from a motor driving the feed screw and the opening and closing of the by-pass.

4. A machine according to any of claims 1 to 3, in which the supply of fluid to the motor driving the extrusion screw is controlled in dependence upon the temperature of the material in the extruder.

5. A machine according to claim 4, in which the control is effective, through an amplifier from a thermocouple adjacent the extrusion orifice, on an hydraulic pump supplying the motor driving the extrusion screw.

6. A machine according to any one of claims 1 to 3, in which the control is effected in dependence upon results received from apparatus which tests the characteristics of the material after extrusion.

7. A machine according to claim 6, in which the testing apparatus is a device for chopping the extruded material, the loading of which device is effective to control the force applied to the extrusion screw.

8. A screw type extruding machine substantially as hereinbefore described and illustrated in Figure 1 of the drawings accompanying the Provisional Specification.

9. A screw type extruding machine substantially as hereinbefore described and illustrated in Figure 2 of the drawings accompanying the Provisional Specification.

EDWARD EVANS & CO.,
53—64 Chancery Lane,
London, W.C.2,
Agents for the Applicant.

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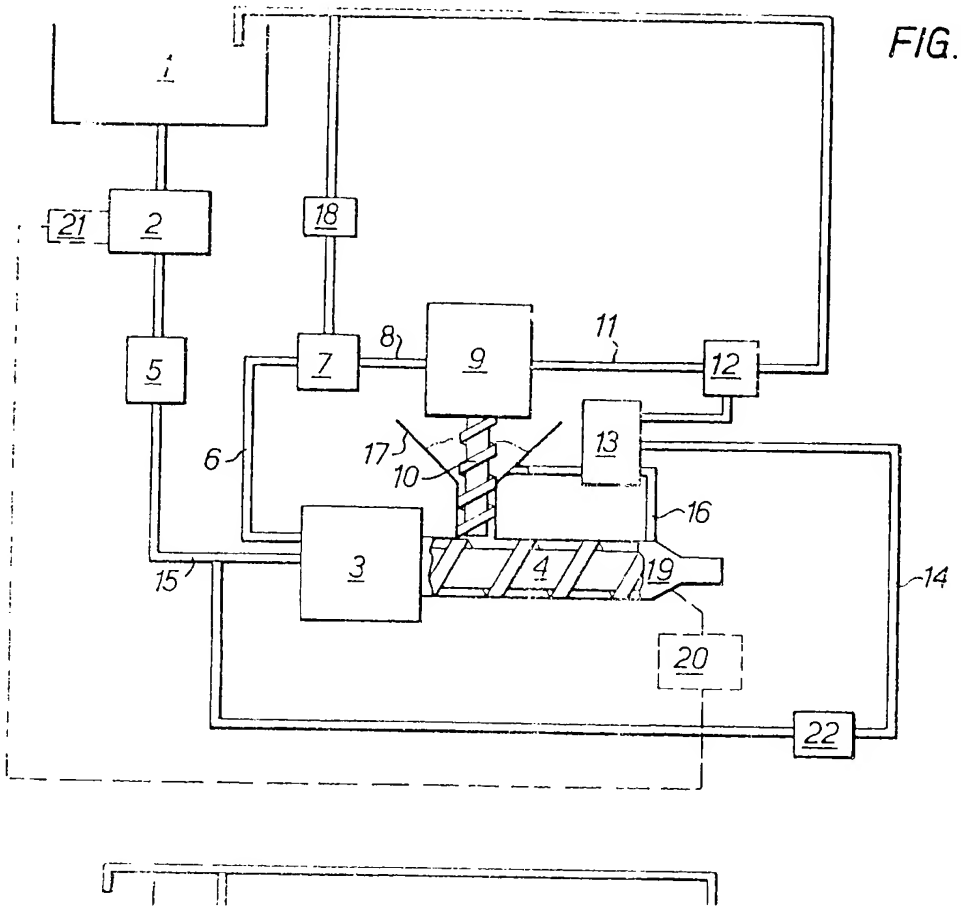

FIG.1.

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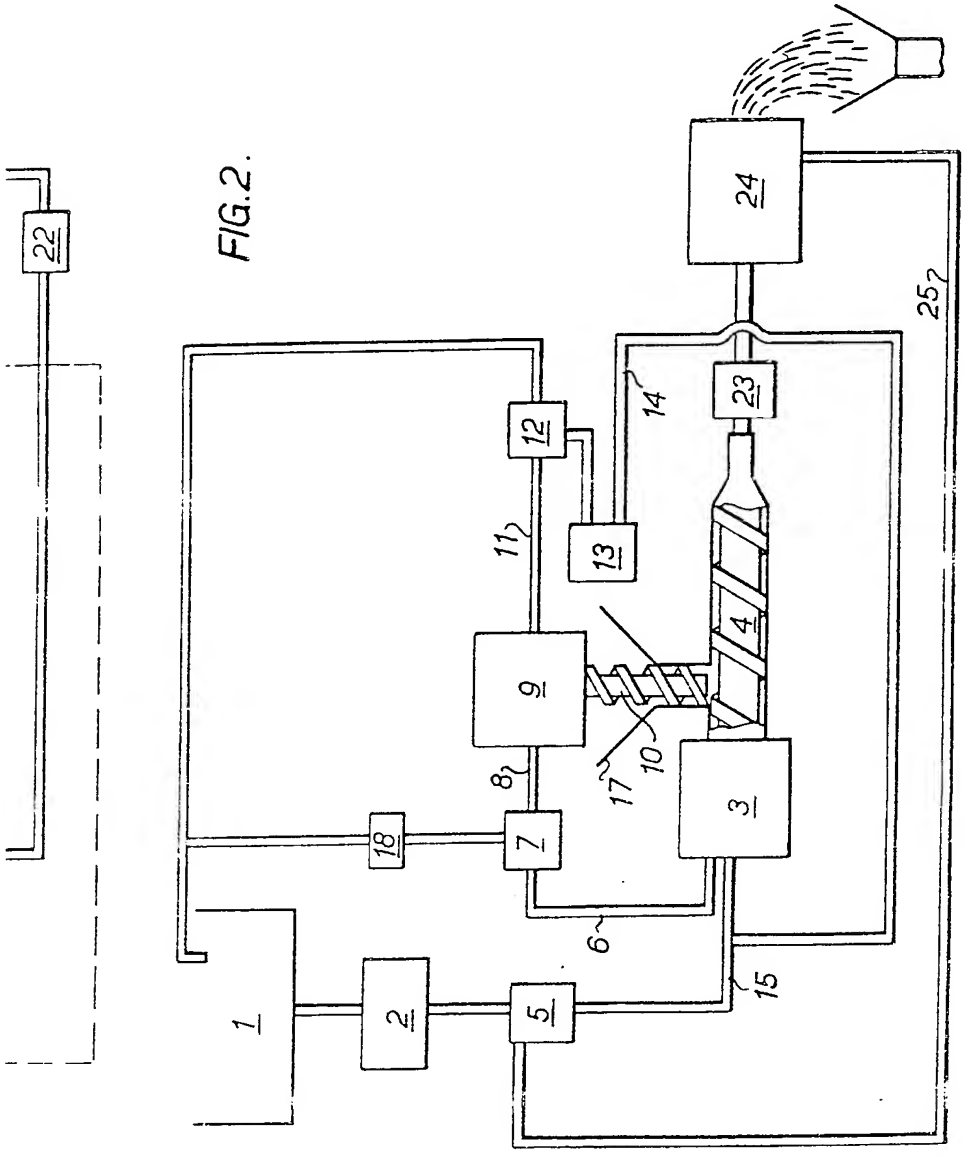
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

FIG.2.



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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 1 & 2

FIG. 1.

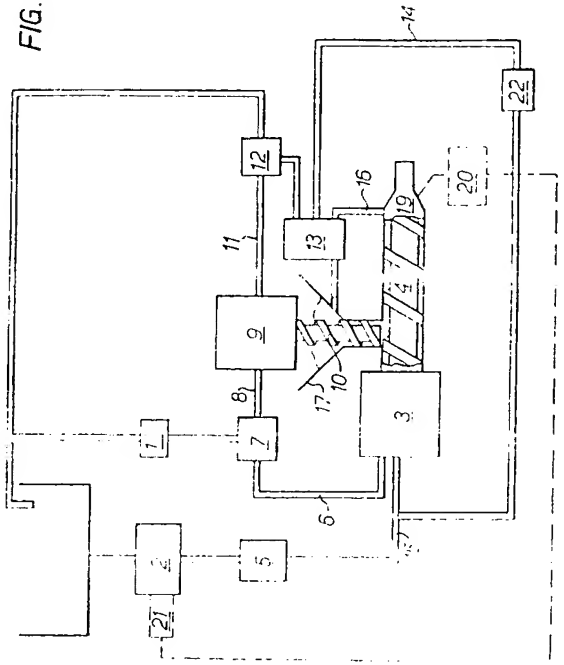

FIG. 2.